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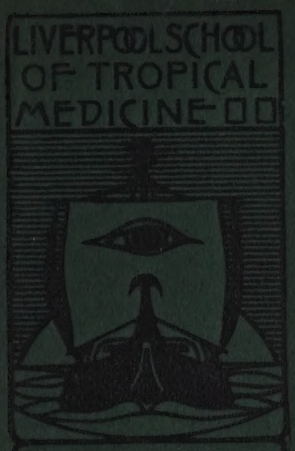

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The Diagnosis and Distribution of Human Trypanosomiasis in the Colony and Protectorate of the Gambia

JOHN L. TODD, M.D.
AND
S. B. WOLBACH, M.D.

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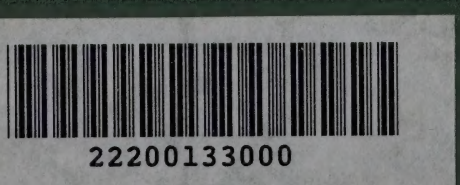
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THE DIAGNOSIS AND DISTRIBUTION OF HUMAN TRYPANOSOMIASIS IN THE COLONY AND PROTECTORATE OF THE GAMBIA

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First Report of the Expedition of the Liverpool School of Tropical Medicine to the Gambia, 1911.

BY

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I. PREFACE

The main objects of an expedition sent to the Colony of the Gambia, in 1911, by the Liverpool School of Tropical Medicine, were to make additional observations on the efficiency of gland puncture in the diagnosis of human trypanosomiasis, and to determine the incidence of that disease in the territory visited by the expedition. The present paper reports on this part of our work; observations on other points will be reported on in later papers. That a few cases of human trypanosomiasis may usually be found in the Gambia is shown by the discovery there, in 1901-02, of *Trypanosoma gambiense* in two Europeans and in six natives[1]. Since then the parasite has been found in one other European and in [4] several natives. In a report made for the Under Secretary of State, in 1910, Dr. Hopkinson states that there are about six cases of trypanosomiasis among the 1,500 new cases whom he sees yearly; he suggests that about 1 per cent. of the patients coming to the hospital at Bathurst are cases of trypanosomiasis[4]. The figures published in the report of the Senior Medical Officer, Dr. Hood, for 1909, would make it appear that the number of cases is rather less than this; for there were no cases of trypanosomiasis recorded among almost 8,000 patients treated during that year at the Bathurst Hospital, and only one among 1,117 treated at the McCarthy Island Hospital. In 1908, however, there was one death from trypanosomiasis among 593 patients admitted to the Bathurst Hospital.

All of these observations prove that human trypanosomiasis has been endemic in the Gambia for some years; the Gambia, consequently, offered an excellent field for testing the efficiency of gland palpation and puncture in the diagnosis of human trypanosomiasis. The Gambia furnished an exceptionally good opportunity for a test, since it has been suggested that gland palpation is most likely to prove untrustworthy in those localities where human trypanosomiasis exists in an endemic, rather than in an epidemic form. It has often been suggested that palpation, controlled by gland puncture, could not be usefully employed in detecting cases of trypanosomiasis, because many natives who live in areas where sleeping sickness occurs sporadically, have enlarged

glands without obvious cause, and that all of them could not possibly be infected with trypanosomes. Indeed, when human trypanosomiasis was first described in the Gambia[1], it was considered inadvisable to lay much stress on the diagnostic importance of the enlarged lymphatic glands existing in the cases in whom trypanosomes were found, since no trypanosomes were found in the blood of other, apparently healthy, natives whose glands were also enlarged. Eventually, experience in the Congo Free State led to the publication of reports in which it was concluded that, in areas where human trypanosomiasis exists, all negroes with enlarged glands must be considered to be cases of trypanosomiasis until the contrary is proved, and, although it was recognised that all cases of the disease are not detected by gland palpation and puncture, it was urged that this fact should be used as a basis for measures designed to control the spread of sleeping sickness. Many papers have since appeared on the same subject. Some authors conclude that gland palpation and puncture form an efficient diagnostic method, others do not. Those who decry it have usually expected too much from it. Most of the papers which had appeared up to August, 1908, have been reviewed and discussed[3] by one of us. Those which have appeared since then have been abstracted in the Bulletins of the Sleeping Sickness Bureau. These Bulletins also contain full considerations of the literature dealing with the measures employed in the diagnosis of human trypanosomiasis, and the Director of the Sleeping Sickness Bureau has published reviews of them[5, 12]. Broden and Rodhain[6], Thiroux and d'Anfreville[7], the German Sleeping Sickness Commission in Togoland[8], the Sleeping Sickness Commission in French Congo[9], the German Sleeping Sickness Commission in East Africa[10], Kinghorn and Montgomery[11], Davey, Stannus, Park and Barclay[13], Horn[14], Kinghorn[15, 16, 21], Sanderson[18], May[19], Drew[20], have all written papers on this subject. All these authors have employed gland palpation and puncture, and have found them of value; there is, however, considerable variation in the opinions they express concerning the exactness of the results obtained by these methods.

References are given to the abstracts in the Bulletins rather than to the original papers, because the former are much more easily

obtained by most persons. It would be unprofitable to enter upon a second consideration of these papers; especially since one would necessarily traverse, almost exactly, the ground covered by a previous review[3]. More recently Kinghorn and Montgomery have given an excellent review of the subject[11].

The figures obtained by our work in the Gambia speak for themselves; the results there entirely coincide with those obtained in the Congo. Consequently, the conclusions reached in the Congo are left unaltered. It seems strange that our results should differ so widely from those of other authors. Koch stated in East Africa that '50 per cent. of trypanosome carriers could be detected by a single examination of the blood'; the statement would have been impossible if the carriers examined had been the early cases occurring in the Gambia and in the Congo Free State.

Thanks are due by us for favours and assistance received during this expedition from the Elder Dempster Steamship Company, from the Governor, the officials and merchants in the Colony of the Gambia, and from M. Legrand and M. Lanzerac in French territory.

II. INTRODUCTION

Because human trypanosomiasis is endemic in the Gambia, that territory offered an excellent opportunity for testing the efficiency of gland palpation and puncture in the diagnosis of that disease. The expedition sent out for the purpose determined to examine as many natives as possible in all parts of the colony, in order to avoid any errors which might be produced by local causes.

The expedition reached Bathurst, the capital of the Colony of the Gambia, on the 4th of February, 1911. Five days were spent in making the necessary arrangements, and work was commenced on the 10th of February. Ninety days were spent in travelling through the Protectorate and five in examining Bathurst and its neighbourhood. In all, the expedition spent one hundred days in the Gambia. During that time it travelled about 550 miles, and it palpated the necks of 12,298 natives drawn from ninety-five towns and villages. Trypanosomes were found in seventy-nine persons. If to these be added twenty-one persons with much enlarged glands, whom it was impossible to puncture and who

were almost certainly infected, a total of one hundred is obtained; consequently, at least, 0·8 per cent. of the whole population of the Gambia are probably infected with trypanosomes. From the observations made by previous expeditions to the Gambia, and from the reports made by resident medical officers[4] it was already known that *Glossina palpalis* was very common everywhere along the Gambia and its tributaries, and that *Glossina morsitans* also occurred there. During this expedition *Glossina palpalis* was seen in varying numbers, wherever the neighbourhood of the river, or of a stream, was remained in for any length of time. Several areas, on both sides of the river were passed through in which swarms of *Glossina morsitans* occurred, and it was seen in very many places, far from any water, in smaller numbers. No reason was observed for the irregularity in their distribution. Tabanids and sand-flies were very common.

On the accompanying map the towns visited are underlined, and the route followed by the expedition is indicated by an unbroken line; so far as it was possible, examples of every type of country, included in the 5,000 square miles of the Colony and of the Protectorate of the Gambia, were visited.

The expedition was undertaken during the dry season because it is almost impossible, for Europeans at least, to travel in the Gambia during the rains. The dry season there lasts from about November to June.

During the height of the dry season there is very little water in the country. The swamps are dry and the river becomes little more than an arm of the sea in which fresh water lies; at this time of the year the tides are felt at Fatta Tenda, about 240 miles inland by the river from Bathurst. There is, consequently, very little fall to the river, and the country through which it runs is very flat. During the rains the river is swollen so that it sometimes passes the banks and its current becomes so rapid that sailing boats require weeks to make journeys which can be made in days during the dry season. At this time of the year the swamps and creeks are all flooded so that it becomes almost impossible to travel by any of the roads running near the river.

At its mouth, and for some eighty miles up stream, the river and the creeks tributary to it are bordered by dense fringes of

mangrove trees. The fringe of mangroves varies in width from ten to fifty or more yards. Beyond the mangroves there are often extensive grass-covered, swampy plains; such plains are very characteristic of the Gambian Protectorate, and they occur on both sides of the river all the way from the sea to the end of British territory, some 200 miles inland. From the swamps the land rises gradually to the level plain, of which the greater part of British territory consists. This plain is composed of sandy soil and, where it is uncultivated, is usually covered by forest composed of scrubby trees and bamboo. Near water-courses, or on low-lying ground, there are a few heavily forested areas. The plain varies considerably in width, but practically all of it is included in British territory, which is merely a strip of land, ten kilometres in width, on both sides of the winding river. It is evident that the Gambia has not always occupied its present bed, and that the level country on either side of the river is part of the wide valley which it has eroded. The valley is limited more or less abruptly by higher ground. Sometimes it is limited by high escarpments of red, volcanic iron-stone or by cliffs going down many feet to the river; sometimes the rise is gradual to a plateau only a few feet above the river, which is covered by scrubby forest and interrupted by out-croppings of the constantly recurring, red, volcanic rock.

A few Niuminkas living at Bathurst are fishermen by profession. Some of the Mandingoes and Jolloffs living along the sea-coast or in villages situated near the banks of the river, in the lower part of its course, own canoes and often catch fish. With these exceptions the whole of the population of the Gambia is agricultural or pastoral, and no tribe gains any considerable part of its food from the river. Almost every village, however, looks forward to scooping, with hand-nets, a few fish from the ponds left in the dried-up swamps at the end of the dry season.

The population of the Gambia consists mainly of Mandingoes, Jolloffs and Jolahs; these tribes are mentioned in the order of their importance. There is also a considerable number of Foulahs. The customs of Mandingoes, Jolloffs and Jolahs are very similar; they are all agricultural peoples who build their villages near their fields, and grow ground-nuts, millet of several varieties, rice, beans, Indian corn, gourds, pumpkins, and medicinal herbs of various

sorts, as well as cotton. The chief difference between them is that the Jolahs are more primitive than the other tribes. Unlike them, they are not Mahomedans; they drink palm wine and live in primitive hamlets, not in villages. They are very independent and much more difficult to control than their more civilised neighbours; if it were advisable to do so it might be difficult to persuade them to adopt measures designed to prevent the extension of sleeping sickness among them. With the exception of a few insignificant Mandingoe villages almost all of the native towns in the Gambia are built at some distance—half a mile or more—from the banks of the river. Indeed, one Mandingoe chief said that his people know that 'it is not healthy to build a town near too much water.'

The Foulahs are pastoral people. They are most numerous far up the river; but they occur throughout the Colony. They move, with their cattle, from grazing-ground to grazing-ground. In the wet season they leave the river for the interior, where their cattle are not exposed to fly-bites; in the dry season they return to the river for the sake of the grass and water in the swamps along its banks. Consequently, the Foulahs build no towns but, at the most, only temporary collections of huts.

All the tribes in the Gambia are very prosperous. Their cattle have increased enormously in number and their land is fertile. They raise good crops of millet and rice for their own use, and large amounts of ground-nuts which are sold to traders for export to Europe. With the money obtained from the sale of ground-nuts the natives are able to buy all the European articles, such as cloth and powder, which they require. Because of the favourable conditions for obtaining money by the sale of ground-nuts, large numbers of young men yearly come to British territory in order to make farms and raise crops of ground-nuts. They come from French territory, from all directions; some of them come from places distant eight, and even more, weeks' travel.

Eleven cases of clinical 'sleeping sickness' were seen during the expedition. Although the disease has existed in the Gambia for some years, and although single cases have been seen in every part of the colony, it has never become epidemic; neither do cases ever seem to have been very common. In 1902[2] the blood of 1,043 natives was examined by cover-slip preparations; six of them,

0·5 per cent., were found to be infected with trypanosomes. During this expedition the blood of 362 persons, selected by gland palpation, was examined in exactly the same way; trypanosomes were found in seven, 1·9 per cent. After examining three cover-slip preparations the parasites were found in the blood of an eighth case, in whose gland-juice they had been seen previously. From these figures it seems possible that human trypanosomiasis in the Gambia may be tending to increase. It is interesting that three cases were found in Lammin among 100 persons examined, in 1902; in 1911 three cases were found there among thirty-five persons whose blood was examined.

The natives of all the tribes know the disease well (the Mandingoes call it *Kanta bero*,* the Jolloffs, *Nelouan*, and the Foulahs, *Doïngol* or *Danu*). Nevertheless, answers to our questions concerning the presence of sleeping sickness were sometimes given which seemed to be almost wilful in their strangeness. For example, the chief at Essau, where 5·4 per cent. of the population had trypanosomiasis, professed to be able to remember only one case of sleeping sickness among the people of his village.

Every headman was questioned; but none gave any hint of a tradition that sleeping sickness had ever been more prevalent than it is at present, and none knew when the disease first came to the Gambia, though they all agreed that it had been in the country for two or three generations. Natives told Dr. Hopkinson that, formerly, no towns were built near Nianija Bolon (creek) on the north bank because persons living there were in danger of catching sleeping sickness. It is probable that the situation of the native towns, among fields at some distance from the river, and the agricultural habits of the natives—which make it unnecessary for the men to go frequently to the river—have had some effect in preventing the spread of the disease.

M. Legrand, the Administrator of the French Territory to the South of the Gambia, wrote that he has been travelling through the district of Fulladu for two years, and that all the natives living in that district are well acquainted with sleeping sickness. He, with Dr. Dufougére, estimated that about 0·15 per cent. of the natives

* This term really means 'neck stones' and refers to the enlarged glands; *Sina jankers* refers directly to the disease.

there were infected with trypanosomiasis. Most of the cases were young men who had gone to British territory along the Gambia to farm during the rainy season; but tsetses do exist in Fulladu about the marshes, so that cases of trypanosomiasis do occur there among natives who have never been to the Gambia. M. Lanzarec, the French resident in the territory to the North of the Gambia, had also noticed that sleeping sickness occurred most frequently among those natives who had farmed in British territory. It is certain that the men who cultivate millet and ground-nuts in the Gambia do run some danger of being bitten by tsetse-flies. Natives often stated that they were bitten while they were at work by flies, which they called *Solo-fing jolo* or *Kongjolo*. Both *Glossina palpalis* and *G. morsitans* are probably included under these names; we saw no other small species of tsetse-flies in the Gambia. It was frequently said that the flies were most numerous in the wet season and that —this we saw—*Glossina palpalis* often followed persons who had come from the water-side into towns situated half a mile or more from the river bank. It is, however, the women who are most exposed to tsetse-flies. They alone cultivate rice. The rice-fields are always placed in the swamps, and they often lie within a hundred yards or so of the river, consequently, those who work in them, as the natives freely admit, must be frequently bitten by tsetses.

A French trader, who passed the rainy season of 1909 at Jamekunda, near Sallikeni, said that this town has many rice-fields which are situated near an arm of the river. As is usual, they are worked by the women, with the result that many women have died of sleeping sickness, and one man lost five wives from that disease in two years.

Young children are usually carried wrapped in a shawl on their mothers' backs. They are consequently little exposed to infection. Boys are sent on errands, and run about everywhere; while girls help their mothers in household work, in drawing water and in farming; so both boys and girls are exposed to the bites of flies; the boys are, perhaps, more exposed than the girls. As has been pointed out, the women are much more exposed than are the men, because they cultivate rice. In maturity and in old age both men and women, provided they have children or slaves to maintain them, do little work afield, and remain very largely within the villages. A consideration of the usual occupations of the natives in the Gambia would lead to the conclusion that in childhood males

are more likely to be bitten by tsetse-flies than are females; but that in adult life, where rice is grown, females are more likely to be bitten than men and, moreover, that females are likely to be bitten more often than any other class of the population. It would consequently seem as though the women were more liable to become infected by trypanosomes than are men. An inspection of Table III is interesting in this connection. It may be noted here that because of their habits the pastoral Foulahs are little exposed to infection; few of them have much enlarged glands and no case of trypanosomiasis was found among them.

In the Gambia, as in many other places along the West Coast of Africa, the natives of all conditions and tribes realise that the occurrence of enlarged glands is one of the earliest signs of 'sleeping sickness.' Some of them, at least, also recognise that change of character, unstable emotions—easily excited tears or laughter—and irritability are often early signs. Dr. Hopkinson has been told by natives that an early sign is delay of the eyelids in following the eyes when an affected person looks down. Many natives realise that frenzy and mania are often late symptoms of the disease which may exist before somnolence appears. One headman had noticed that persons who scratched much often had sleeping sickness.

Many tribes along the West Coast of Africa practice gland excision as a preventative of sleeping sickness; the Jolloffs, Mandingoes and, apparently to a less extent, the Jolahs and Foulahs all do so. Sometimes glands are undoubtedly removed with a knife and a bit of wire. Often none can have been reached[4] through the incision which is very frequently made high up, on the ramus of the jaw, in a situation from which it would be almost impossible to remove a gland; in these instances it seems almost certain that no glands were removed. In other cases incisions have been made in favourable places beneath the jaw, in the anterior or posterior triangles of the neck and in the axillae; in these instances it seems very probable that glands were excised. There are some men who profess to remove glands by plasters, which 'draw' them out. Something of the same sort is done by natives in Nigeria and on the Ivory Coast.

The natives, even those who are most educated, believe in the

advisability of gland excision, and believe, more or less firmly, that the removal of glands will prevent the development of sleeping sickness. They usually say, however, that excision is only of value in the early stages, and that it is useless to remove glands when the sickness has 'gone into the body.'

Very many of the natives living in the Gambia have had glands removed. The fact that 150 out of 220 consecutive persons chosen for gland puncture had had glands excised will give some idea of the extent of the practice. In some districts excision is more general than in others; the Jolahs seem to practise it least of all. Usually, the operation is done but once on each individual; not infrequently, persons are met with who have, as they say, had their 'bumps pulled' on several occasions. Some of these have trypanosomiasis.

One woman, aged 24, in whom trypanosomes were found, had had glands removed when she was about 13 years old. Since then, on three occasions, glands were said to have been removed from the sub-maxillary, posterior cervical and axillary groups.

One case of clinical trypanosomiasis had had glands excised on five occasions during as many years.

Several persons in whom trypanosomes were not found had had their 'bumps pulled' three times; usually the operation is only done once, in childhood. The natives all know that people above middle age rarely have enlarged glands and, consequently, that they rarely have sleeping sickness (see Table I).

III. PROCEDURE

It is estimated that there are over 200,000 negroes in the Gambia. In order that those whom we examined might represent a fair sample of the whole population, persons were examined in every part of the Colony and Protectorate. As many persons as was possible were examined in each village visited. The natives were not called together for us to see them, but we went from house to house and entered the huts in order to make certain that cases were not being concealed. As the posterior cervical glands of each native were palpated, the age, sex, and degree or absence of enlargement of the glands was dictated to a clerk who noted them; these notes were kept for a series of 9,069 persons. Notes of only those with puncturable glands were made for the remainder of the 12,298 persons palpated.

So soon as palpation of a village was finished, all of those who had puncturable glands were told to go to the camp of the expedition to be examined. One of the objects of the expedition was to compare the efficiency of the various methods of diagnosing trypanosomiasis; so, in a series of 283 persons, observations on the following points were made for each native examined: personal history, pulse, temperature, size of spleen, whether the glands had been excised, presence of enlargement in all the groups of superficial lymphatic glands, the presence of scurf, tartar, skin disease, or of any cause which might produce glandular enlargement, and the presence of trypanosomes in gland juice or blood. The blood was searched for trypanosomes by the examination of fresh cover-slip preparations, of thick films and of smears. At first it was intended to also centrifugalise the blood by either our own method or by that first employed by those who worked in Uganda[5]. Both of these methods are tedious, and it soon became evident that it would be necessary to abandon all hope of using them if a serious number of gland punctures was to be done in the time at our disposal. In the remainder of the 350 persons whose glands were punctured, the full examination was made on only those in whom trypanosomes were found; for the others the results of the examination of blood and gland juice alone were recorded.

The names and descriptions of all those who were punctured have been given to the Senior Medical Officer and to the Commissioner of the district in which they were seen. It is hoped to keep track of them, and in this way to gain information on at least two very interesting points, namely: 'Do all untreated cases of human trypanosomiasis in natives end fatally?' and 'Are any of the persons with moderately enlarged glands, and in whom no trypanosomes could be found, really cases of trypanosomiasis?' With the exception of the young men, natives in the Gambia travel but little, because they are prosperous and contented. They are well under control and they are usually very amenable to European rule. It is, consequently, probable that it will be possible to keep track of these persons. It is very important that they should not be lost sight of; the probability that they could, and would, be kept under observation was one of the reasons which determined the sending of this expedition to the Colony of the Gambia.

IV. TECHNIQUE

In order to establish a just basis for comparing the various methods of diagnosing trypanosomiasis, a definite routine of examination was established.

All the observations on each case used in making our comparison were made at the same time. The blood preparations were made with blood drawn from a single finger. The gland punctured was usually the most convenient one in either of the posterior cervical groups. If glands from any other group were punctured the fact has been noted. It has been strongly insisted that only perfect specimens of gland juice should be examined, for a negative examination of an imperfect preparation of gland juice has absolutely no significance[2]. Consequently, only examinations of good preparations of gland juice and of blood have been recorded. As a rule only one preparation was made by each method of examination, if more were examined the fact has been noted. A microscope used in searching for trypanosomes should always be fitted with a mechanical stage so that it becomes possible to make certain of missing no part of the preparation examined.

A. *Fresh cover-slip preparations.*

The simplest method of finding trypanosomes in a patient is to place a drop of his blood between a slide and a cover-slip and to search in it for the living parasites with a microscope. The trypanosomes are detected by their movement, so the preparation must not be too thick lest the movements of the parasites should be obscured by the blood cells. As usual, our fresh preparations were made with cover-slips, three-quarters of an inch square, and they were examined with a Zeiss, D. objective and a No. 4* eye-piece.

B. *Thin blood smears.*

In making a thin smear a drop of blood, half as large again as that used in making a cover-slip preparation, is placed at one end of a slide. Then, with a needle, placed transversely across the drop, the blood is smeared along the slide in a thin layer. Our smears were allowed to dry and they were then fixed in absolute alcohol and stained by Giemsa's method.

C. *Thick blood films.*

Four or five drops of blood as large as those used in making thin smears, are placed on a glass slide over a circular area about

one centimetre in diameter. The slides are then usually fixed by heat, de-haemoglobinised in distilled water and stained by some modification of Romanowsky's method. The value of the method depends upon the well-known manoeuvre of removing the haemoglobin; haemoglobin stains densely so that, were it present, it would be impossible to see parasites lying among the red blood cells.

D. *Centrifugalisation of the blood.*

Only a few specimens of blood were centrifugalised. We are quite aware of the advantages offered by the method, but the length of time required for employing it, as well as the large amount of blood, 10 c.cm., required for the most usually employed method of centrifugalising, makes it almost impossible for it to be used in the routine examination of a large number of persons. We regret that those in whom trypanosomes were found by other methods were not examined by this one; but lack of time and the fear of frightening natives by taking the necessary blood from them prevented us from doing so.

E. *Auto-agglutination of the red blood cells.*

It has been noted frequently, in fresh cover-slip preparations, that the red blood cells of persons suffering from trypanosomiasis very often run together to form shapeless masses. The term of auto-agglutination has been applied to this phenomenon.

F. *Gland palpation.*

The classification employed for grouping the persons palpated according to the absence of glandular enlargement or according to the degree of it, if it were present, was that proposed in the Congo[2]. Those with enlarged posterior cervical glands are grouped in the following way, according to the degree of enlargement present. As '+' are classified persons with posterior triangles which contain (*a*) one gland which is estimated to measure at least 1·5 by 0·75 cm., or (*b*) three or more smaller glands, the largest measuring perhaps 1 by 0·5 cm. As '+ —' are classified enlargements, less than this, but greater than those classified as '+ — —.' As '+ — —' are classified groups containing only one or two glands measuring 0·5 by 0·25 cm., or (*b*) many tiny shot-like glands which are only just palpable.

G. *Gland puncture.*

No change was made in the technique developed in the Congo Free State[2]. Ordinary hypodermic syringes were used. The gland was fixed with the left hand while the needle of the syringe was passed into it, with a sharp thrust, by the right. The plunger was withdrawn by an assistant while the point of the needle was gently moved about within the gland. The plunger was released and the syringe withdrawn. The tiny droplet of fluid, which was usually all that was obtained, was then blown out by a single thrust of the plunger, and examined immediately in the same way as a fresh preparation of blood was examined. The necessity of avoiding the dangers mentioned in former papers[2] was more than ever evident. The preparations must be thin, and care must be taken to use clean slides and cover-slips and to see that the morsel of skin punched out by the needle is not contained in the specimen. If the preparation contains water from the syringe, or air bubbles, it is not a good one, and the chance of finding living trypanosomes in it is lessened. Trypanosomes are also less likely to be seen in pus-like preparations, in which the cells are dull, than in preparations filled with clear, brightly refractive cells. Those who attempt to examine a person suspected of trypanosomiasis by gland puncture must not record a negative examination until they have examined, in perfect preparations, all of the material obtained by the successful aspiration of a gland. Although there is usually very little blood in a preparation of gland juice, the presence of even a considerable number of red cells seems to make no difference to the likelihood of trypanosomes being found.

V. FINDINGS

A. *Fresh cover-slip preparations.*

The blood of 362 persons was examined by cover-slip preparations; trypanosomes were found in eight of them. A series of 340 persons were examined by gland puncture and by cover-slip preparation; gland puncture detected sixty-six cases of trypanosomiasis, including all of six instances in which simultaneous examination of cover-slip preparations was successful in finding trypanosomes. It was necessary to examine three cover-slip

preparations from one of these cases before the parasites, already seen in gland juice, could be found in the blood.

B. *Thin blood smears.*

Thin blood smears were examined from 316 persons. Trypanosomes were found in ten of them; the parasites had also been seen in three of these cases in cover-slip preparations made at the same time as the smears. They were also found by the examination of cover-slip preparations in five persons in whom the examination of thin smears had failed to find them. Gland puncture found forty-eight cases of trypanosomiasis among these 316 persons.

C. *Thick blood films.*

Thick blood films, prepared in the manner described, were examined from 265 persons. Trypanosomes were found in only eight of them by this method, while they were found in forty-seven by gland puncture, in ten by the examination of thin smears, and in five by the examination of cover-slip preparations. All the thick films in infected cases were examined during half an hour at least. One film of blood in which trypanosomes had been found by thin smears was examined without result for three-quarters of an hour and another one was examined in the same way for an hour. Three thin smears were examined without finding trypanosomes in a case in whom the parasites had been found by the thick film method.

D. *Centrifugalisation of the blood.*

The blood of only three persons was centrifugalised. Ten c.cm. of blood was drawn from a vein in each case and centrifugalised three times; over an hour and a half was spent in the preparing and examining of from two to four cover-slip preparations from each person. Trypanosomes were found in none of them, although they had been previously found by gland puncture in two of them.

E. *Auto-agglutination.*

When it was first described, it was decided that auto-agglutination was not always present in trypanosomiasis, but that it often did occur in persons and in animals who were suffering from that disease, and it was concluded that though auto-agglutination

had no diagnostic value it frequently encouraged a successful search for trypanosomes in persons in whom they were not at first found.

A good deal of attention has been given to auto-agglutination recently[24]. For this reason the cover-slip preparations made from 350 persons, whose glands were punctured, were examined for auto-agglutination. These persons have been classified, in Table I, according as trypanosomes were found in them or not. They are further divided into four classes according to the absence of auto-agglutination, or according to the amount of it which was present. An inspection of the table shows that well-marked auto-agglutination may be present in persons who are not infected with trypanosomes, and also that some degree of auto-agglutination is very constantly present in persons who are infected with trypanosomiasis, although it may be absent altogether from some of them. It is worth noting that trypanosomes were probably present in two of those persons in whom the parasites were not seen, although auto-agglutination was well marked; most of our cases were only examined once and the presence of a slight temperature with enlarged glands and auto-agglutination makes it probable that trypanosomes would have been found in these two cases had the search for the parasites been persevered in.

Table I

	Marked agglutination	Slight agglutination	Very slight agglutination	No agglutination
Trypanosomes not present ...	11	37	59	176
Trypanosomes present	26	15	14	12

F. *Gland palpation and puncture.*

The classification of persons with enlarged cervical glands which was proposed in the Congo Free State has been retained. This classification has been adhered to because it seems to be a reasonable one and a useful one. It is reasonable because nothing can be clearer and less 'mysterious' than reference to actual measurements, and because it can be appreciated by every doctor; many physicians

have never seen ' familiar objects,' such as pigeon's eggs, filberts and pfennig pieces, but every medical man should have a very accurate knowledge of the length of one centimetre. It would be misleading to divide glands into puncturable and unpuncturable, because after a little practice, anyone can draw gland juice from glands which he would, at first, have thought unpuncturable. It is a useful classification because the results of our examinations show every negro with ' + ' glands, without some evident cause, is, almost invariably, a case of trypanosomiasis. This is especially so if the enlarged glands have the thickly fluctuating consistency to which many observers have alluded (Grey and Tulloch[5], page 61). As a rule, only a few of those classified as ' + — ' have trypanosomes, while almost none of those classed as ' + — — ' have been found to be infected. These points are illustrated by the following table of those with enlarged glands seen among the 12,298 persons who were palpated in the Gambia.

TABLE II

Degree of glandular enlargement	+	+ —	+ — —	Total
Seen	56	136	2102+	2294+
Punctured	36	63	233	332
Trypanosomes found	36	28	4	68

It will be noticed that trypanosomes were found in the gland juice of all of the thirty-six ' + ' cases. The parasites were also found in twenty-eight out of sixty-three ' + — ' cases; they were also seen in four out of 233 ' + — — ' cases. The number of cases classed as ' + — ' and ' + — — ' in whom trypanosomes were found is, proportionally, much larger than it was in the Congo[2].

It will be noticed from Tables II and III that there were a considerable number of infected persons among those who were classified as ' + — ' and ' + — — '. This is to be explained, in part at least, by our having classified those in whom there was a difference between the degree of enlargement present in the posterior triangles of the neck according to the triangle which showed the lesser enlargement. Consequently, of the four positive cases who had

' + — —' glands on one side, two had ' + ' glands on the other side of the neck, and two had ' + —' glands.

The posterior cervical glands were taken as an index of the general enlargement of lymphatic glands which occurs in human trypanosomiasis, just as in the Congo, because they are the groups least exposed to the usual casual causes which produce enlarged glands.

In order to ascertain whether the enlargement of lymphatic gland groups was general in persons infected with trypanosomes, and in order to ascertain whether enlarged glands frequently occurred from other causes than trypanosomiasis in the Gambia, all of the gland groups of 312 persons were palpated. Dr. Hopkinson states[4] that the Jolloffs have enlarged glands more frequently than members of any other tribe. We did not notice that difference, but it was apparent that the Foulahs, and the few Jolahs whom we saw, had fewer persons with enlarged neck glands that had the Mandingoes and Jolloffs who lived near them.

As a rule, all early cases of trypanosomiasis had a considerable degree of general glandular enlargement, but there were six early cases who had one or more gland groups, usually the axillary, epitrochlear or sub-maxillary, not at all or only slightly enlarged. A little watching, however, would probably have discovered signs in at least one of these cases, who had a temperature of 100° F., which would have caused it to be called a well advanced case; it is well known that the size of the lymphatic glands diminishes in advanced trypanosomiasis, and that the value of gland palpation and gland puncture is least in just those cases which can be recognised more easily by clinical, rather than by laboratory methods.[2]

An inspection of the results of the palpations (Table III) shows that children, boys especially, are most likely to have enlarged glands; this is probably because of their lack of personal cleanliness.

Boys often have more or less generalised skin disease, usually 'craw-craw,' they very frequently have a good deal of scurf, and almost always a certain amount of tartar. The frequency of foul mouths and of a high grade of pyorrhoea is very great among the Gambian natives of all ages and classes. All these things often

caused enlarged glands; the slightly enlarged posterior cervical glands of a large number of boys were certainly due to scurf; while enlarged sub-maxillary glands, in persons who had no other groups enlarged, were usually due to an infected mouth. Lice, and cuts or scratches on various parts of the body were also frequent causes of enlarged glands. A considerable degree of enlargement of the groin glands was almost universal among men.

Four or five of the persons in whom trypanosomes were found had evident reasons for their enlarged glands; so the presence of an adequate explanation, such as a dirty, crust-covered head, for enlarged cervical glands by no means excuses their not being punctured. This is especially so since lack of personal care is very usual in established trypanosomiasis.

It is worth repeating—'until the contrary is proved every native with enlarged glands must be suspected of trypanosomiasis.'

Table III shows the incidence of enlarged glands and of trypanosomiasis among 9,069 natives who have been classified according to their sex and age in order to ascertain whether any class in the Gambia is especially liable to be infected with trypanosomiasis.

Up to about fourteen, native boys are still children, after that they become men and work in the fields. After forty-five, as a rule, men have acquired a competence which allows them to rank as leaders in the direction, rather than in the execution of affairs. Up to twelve, girls are children, but after that they commence to spend the whole of their time in women's work. After forty, women are usually scarcely strong enough to do the hard work which falls to women of middle age. It is for these reasons that the divisions according to age have been made at the years specified in the table. An inspection of the table shows that approximately an equal number of males and females were examined.

There were eleven cases of trypanosomiasis in male children and five in female; but there were twenty-two cases of trypanosomiasis in adult males and twenty in adult females. There were no cases of trypanosomiasis in aged persons of either sex. These differences are not large ones, but they indicate that if any class in the Gambia is especially affected by trypanosomiasis it is that class which is most exposed, by reason of its occupation, to the bites of tsetse-flies.

TABLE III

Persons examined		Male 4714			Female 4355			Totals	
Age		0-14	14-45	45-X	0-12	12-40	40-X		
Size of glands	Seen	10	13	1	4	15	0	43	43
+	Punctured ...	3	12	0	2	10	0	27	
	Positive ...	3	12	0	2	10	0	27	
	Seen	45	22	0	25	24	2	118	118
+ —	Punctured ...	22	9	0	7	18	0	56	
	Positive ...	5	5	0	3	12	0	25	
	Seen	850	431	54	407	317	29	2088	2088
+ — —	Punctured ...	107	32	0	31	23	0	193	
	Positive ...	1	2	0	0	1	0	4	
	Seen	1119	1734	435	975	1927	630	6820	6820
—	Punctured ...	7	4	0	3	4	0	18	
	Positive ...	0	0	0	0	0	0	0	
	Totals ...	2024	2200	490	1411	2283	661		9069

Much the same result is obtained in Table IV, where all the cases of trypanosomiasis seen by us in the Gambia are classified in the same way, according to age and sex. For the purposes of this table all persons with ' + ' glands whom we were unable to puncture are considered to be infected. It is justifiable to do so because trypanosomes were found in all of the thirty-six ' + ' cases who were examined by gland puncture. It will be seen from this table that there are, still, more cases of trypanosomiasis among the male children, while the number of cases in adults is about

equal, and there are no cases in the aged. Results, very similar to these, were obtained by Kinghorn and Montgomery in Rhodesia.[11]

TABLE IV

Persons examined	Male			Female			
Age	0-14	14-45	45-X	0-12	12-40	40-X	Totals
Early cases	11	27	0	6	24	0	68
Clinical cases	2	4	0	0	5	0	11
Persons with + glands who were not examined ...	6	7	0	2	6	0	21
Total	19	38	0	8	35	0	100

Table V gives a list of the towns in which natives were palpated, together with the results of the examinations. Its interest is chiefly local; it may serve as a basis for future examinations undertaken to ascertain whether trypanosomiasis is increasing or decreasing in the Gambia.

A comparison of this table with the map shows that no district in the Gambia is especially affected by trypanosomiasis. Towns, such as Mandinaba, Demban Kai and Essau, which are placed near the water have, as is always the case in such towns, an unusually large percentage of their population infected.

Sometimes natives say that more persons die of sleeping sickness during the rains than in the dry season. This probably means only that more persons weakened by trypanosomiasis die of intercurrent infections at that time of the year because of the hardships caused by the unfavourable climatic conditions.

It is regrettable that lack of time and the reluctance of natives to be examined prevented the examination of all the ' + ' and ' + — ' cases. Many more ' + — — ' cases were seen than were examined; but the great majority of those whose cervical glands were puncturable have been examined. It would have been impossible to puncture a gland in the posterior cervical triangles of very many

TABLE V

Degree of glandular enlargement			+			+ —			+ — —				
	Towns	Number palpated	Seen	Punctured	Positive	Seen	Punctured	Positive	Seen	Punctured	Positive	Clinical cases	Probable percentage of Trypanosomiasis
1	Dippa Kunda ...	41	1	0	0	4	2	0	12	0	0	0	2·4
2	Bakotti	45	0	0	0	11	3	0	18	2	0	0	—
3	Lamin	100	1	1	1	9	5	2	43	0	0	0	3
4	French Mission ...	10	0	0	0	0	0	0	3	3	0	0	—
5	Sukuta	100	0	0	0	5	0	0	30	0	0	1	1
6	Gunjur	100	0	0	0	4	4	0	24	4	0	2	2
7	Brikama	100	2	1	1	1	1	1	49	4	0	0	3
8	Sifa	54	0	0	0	13	0	0	21	0	0	0	—
9	Mandinaba	22	3	1	1	1	0	0	3	0	0	0	13·6
10	Tunjina	35	1	0	0	1	0	0	15	0	0	0	2·8
11	Pirang	50	2	1	1	1	0	0	18	0	0	0	4
12	Farraba Banta ...	110	1	1	1	6	6	0	62	4	0	0	0·9
13	Kafuta	77	4	4	4	3	3	0	40	1	0	0	5·2
14	Baijana	27	0	0	0	3	1	1	8	0	0	0	—
15	Somita	100	0	0	0	2	0	0	34	0	0	0	—
16	Demban Kaie ...	46	2	0	0	1	0	0	13	0	0	0	4·3
17	Kassang	25	0	0	0	1	0	0	9	0	0	0	—

TABLE V—*continued*

	Degree of glandular enlargement		+			+ --			+ — —				
	Towns	Number palpated	Seen	Punctured	Positive	Seen	Punctured	Positive	Seen	Punctured	Positive	Clinical cases	Probable percentage of Trypanosomiasis
18	Vintang	100	0	0	0	5	2	1	30	3	0	0	1
19	Kurankoto	9	0	0	0	0	0	0	4	0	0	0	—
20	Barong	109	0	0	0	1	1	1	28	1	1	0	0·9
21	Manduar	103	1	0	0	2	0	0	53	0	0	0	0·9
22	Jali	100	1	0	0	2	0	0	32	0	0	0	1
23	Batteling	120	1	1	1	2	2	1	49	3	0	0	1·6
24	Kwinella	152	0	0	0	2	2	1	45	1	0	0	0·6
25	Mandina	67	0	0	0	1	1	1	26	5	0	0	1·4
26	Kaiaf	130	0	0	0	2	2	1	43	4	0	0	0·7
27	Jappeni	79	1	1	1	2	2	2	26	3	1	0	5
28	Bureng	90	0	0	0	1	1	1	35	1	0	0	0·9
29	Sukuta	202	0	0	0	3	3	3	24	7	1	0	1·9
30	Brikama	107	1	0	0	4	0	0	39	0	0	0	0·9
31	Boraba	110	0	0	0	1	0	0	40	3	0	0	—
32	Sololo	66	0	0	0	0	0	0	38	4	0	0	—
33	Chakunda	84	0	0	0	1	1	1	28	1	0	0	1·2
34	Wellingara	62	1	1	1	0	0	0	21	5	0	0	1·6

TABLE V—*continued*

	Degree of glandular enlargement		+			+—			+— —				
	Towns	Number palpated	Seen	Punctured	Positive	Seen	Punctured	Positive	Seen	Punctured	Positive	Clinical cases	Probable percentage of Trypanosomiasis
35	Kanube	149	0	0	0	0	0	0	35	0	0	0	—
36	Basse	125	2	0	0	1	0	0	48	0	0	1	2·4
37	Kulari	153	0	0	0	2	0	0	68	0	0	0	—
38	Tuba Kuta	63	0	0	0	0	0	0	16	1	0	0	—
39	Sunkunda	132	0	0	0	0	0	0	36	3	0	0	—
40	Kasi Kunda	64	0	0	0	2	0	0	26	1	0	0	—
41	Koina	194	2	2	2	0	0	0	70	15	0	0	1·03
42	Brifu	156	0	0	0	1	1	1	20	10	0	1	1·2
43	Bantonding	212	0	0	0	0	0	0	37	9	0	0	—
44	Sandi Keri	105	0	0	0	0	0	0	4	0	0	0	—
45	Hamedi Siré ...	157	0	0	0	1	0	0	6	0	0	0	—
46	Maka	485	0	0	0	2	2	2	42	22	0	1	0·6
47	Makakaba	179	0	0	0	0	0	0	9	8	0	0	—
48	Kousalong	219	0	0	0	3	0	0	56	0	0	0	—
49	Karantaba Toranca...	55	0	0	0	0	0	0	12	5	0	0	—
50	Karantaba Tabokoto	115	1	1	1	1	1	0	14	7	0	0	0·8
51	Koli Kunda	100	1	1	1	0	0	0	22	3	0	0	1

TABLE V—*continued*

	Degree of glandular enlargement		+			+ —			+ — —				
	Towns	Number palpated	Seen	Punctured	Positive	Seen	Punctured	Positive	Seen	Punctured	Positive	Clinical cases	Probable percentage of Trypanosomiasis
52	Lamin Koto ...	124	1	1	1	0	0	0	18	0	0	0	0·8
53	Bandi...	125	1	1	1	0	0	0	12	0	0	1	1·6
54	McCarthy's Island ...	258	0	0	0	1	1	0	8	5	0	0	—
55	Kai-ai	182	0	0	0	2	1	1	41	5	0	0	0·5
56	Kuntaur	96	0	0	0	1	0	0	15	0	0	0	—
57	Gassan	54	0	0	0	1	1	1	9	0	0	0	1·8
58	Konkokoto	60	0	0	0	1	1	1	6	0	0	0	1·6
59	Jalokunda	212	0	0	0	0	0	0	44	5	0	0	—
60	N'Jaugen	19	0	0	0	0	0	0	3	0	0	0	—
61	Tento	129	0	0	0	0	0	0	28	4	0	0	—
62	N'Jau	242	1	1	1	1	1	0	25	4	0	0	0·4
63	Kau'ur	318	2	2	2	1	1	1	41	5	0	0	0·9
64	Ballanger	314	0	0	0	1	1	0	48	9	0	0	—
65	N'Geyen Sanjal ...	266	0	0	0	0	0	0	9	1	0	0	—
66	Medina	43	0	0	0	0	0	0	4	0	0	0	—
67	M'Bap	71	0	0	0	1	0	0	2	0	0	0	—
68	Sukotto	86	0	0	0	0	0	0	8	0	0	0	—

TABLE V—*continued*

	Degree of glandular enlargement		+			+ —			+ — —				
	Towns	Number palpated	Seen	Punctured	Positive	Seen	Punctured	Positive	Seen	Punctured	Positive	Clinical cases	Probable percentage of Trypanosomiasis
69	Kai-ama	40	0	0	0	1	0	0	5	0	0	0	—
70	Dasilami	55	0	0	0	0	0	0	3	1	0	0	—
71	Farafenni	206	0	0	0	0	0	0	32	5	0	0	—
72	Yallol	35	0	0	0	0	0	0	0	0	0	0	—
73	Illiassa	311	0	0	0	1	1	0	27	5	1	0	0·3
74	Nokunda	252	0	0	0	0	0	0	29	6	0	0	—
75	Nja Kunda	200	0	0	0	0	0	0	23	7	0	0	—
76	Salikeni	167	1	0	0	0	0	0	40	7	0	1	1·2
77	Jammikunda ...	40	1	0	0	0	0	0	4	0	0	1	5
78	Kerewan	260	1	1	1	1	1	0	24	6	0	0	0·3
79	Dasalami	132	1	1	1	1	0	0	20	1	0	0	0·7
80	Bantanding	105	0	0	0	0	0	0	14	1	0	0	—
81	Daramé	50	0	0	0	1	0	0	0	0	0	0	—
82	Walo	62	0	0	0	0	0	0	6	1	0	0	—
83	Dungku	79	0	0	0	0	0	0	10	0	0	0	—
84	Duniajoe (Mandingoe)	111	1	1	1	2	2	2	12	1	0	0	2·7
85	Duniajoe (Jolof) ...	31	1	1	1	1	1	0	3	0	0	0	3·2

TABLE V—*continued*

	Degree of glandular enlargement		+			+ —			+ — —				
	Towns	Number palpated	Seen	Punctured	Positive	Seen	Punctured	Positive	Seen	Punctured	Positive	Clinical cases	Probable percentage of Trypanosomiasis
86	Essau	111	6	5	5	1	0	0	14	0	0	0	5·4
87	Bathurst	1518	7	5	5	7	5	2	*	11	0	1	0·6
88	Bakau	176	2	1	1	1	0	0	7	0	0	0	0·5
89	Waslunga	86	0	0	0	0	0	0	8	0	0	0	—
90	Jessuan	32	0	0	0	0	0	0	1	0	0	0	—
91	Tarancakunda ...	50	1	0	0	0	0	0	6	0	0	0	2
92	Latikunda	90	0	0	0	0	0	0	3	0	0	0	—
93	Sarakunda	39	0	0	0	0	0	0	0	0	0	0	—
94	Mangai Kunda ...	39	0	0	0	1	0	0	4	0	0	0	—
95	Kokoli	27	0	0	0	0	0	0	2	0	0	0	—
		12298	56	36	36	136	63	28	2102+	233	4	11	
			0·4%			1·1%			17%				

* No record was kept of the ' + — — ' cases seen in Bathurst.

of those who have been classified as '+ — —'. Four '+ — —' cases whose neck glands were too small to be punctured were punctured in other groups; trypanosomes were found in none of them. Neither were parasites found in three cases whose neck glands were much enlarged from tuberculosis and contained necrotic material.

G. *Pulse and temperature.*

It has been noticed frequently that a rapid pulse and a slight degree of occasional fever are often early symptoms of human trypanosomiasis. It was, consequently, thought that the presence of both, or either, might be of value in encouraging the search for trypanosomes in early cases of trypanosomiasis in whom the parasites could not be found at a first examination. The pulse rates and temperatures were, therefore, taken in 281 persons whose gland juice, or blood, was examined for trypanosomes. Cover-slip preparations, smears, and thick films were made from the blood of all these persons. It soon became evident that an increased pulse was of little value because the nervousness of the natives on account of the examination often ran up the pulse rates, in even healthy adults, to 100, or more. This was especially true of the children; some of them had never before seen a white man. Our records show many children, and a few men and women, who have normal or only slightly elevated temperatures, and pulse rates of 120 or even 130 beats to the minute. Examination of the blood has shown that some of these persons had malaria; we believe that in most of them the rapid pulse was simply caused by apprehension. As a rule, there was a distinct increase in the pulse rate of the sixty-one infected persons examined to 100, 120, or more, and that with temperatures of only 99° F. This was not always the case, for one man of thirty-five, with trypanosomiasis, had a pulse rate of 63 and a temperature of 99° F. when he was first seen; others had pulse rates of 78, with temperatures between 99° F. and 100° F.

It has long been known that an isolated observation of an abnormally high temperature in a case of trypanosomiasis does not bear a very definite relation to the probability of finding trypanosomes in the peripheral circulation of that case. In the present series there was, almost always, a slightly elevated

temperature, between 99° F. and 100° F. in those in whom trypanosomes were found. Two persons who had no malarial parasites in their blood, had temperatures of over 100° F.; trypanosomes were seen in the blood of only one of them. Apparently healthy persons, especially young adults and children, were often seen in whom neither malaria parasites, trypanosomes, nor any obvious cause for fever could be found, who had temperatures varying between 99° F. and 100° F. We have no explanation to offer. We do not think that the natives' temperatures were inaccurately recorded because of the high temperature of the air which often reached 105° F. or 107° F. The thermometer was always carefully cooled to below 96° F. with water before being used; oral temperatures were always taken, and the native was made to keep his lips tightly closed so long as the thermometer was in his mouth.

VI. THE METHODS OF DIAGNOSING TRYPANOSOMIASIS DISCUSSED AND COMPARED

One object in initiating a comparative series of examinations, by different methods, for the presence of trypanosomes in a series of 283 persons, was not so much to determine which was the most efficient method, but which was the most effectual. It was not wished to determine by which method the largest number of cases could be detected by spending unlimited time in repeated examinations. It was wished to determine which method would discover the largest proportion of cases in the shortest time. For that reason a limit was set on the length of time to be spent in examining preparations made by each of the methods employed.

One cover-slip preparation of blood and one of gland juice were usually examined from each case; if more were examined the fact has been noticed in the comparison of results. About fifteen minutes are required in which to properly examine a $\frac{3}{4}$ inch square cover-slip preparation of blood for living trypanosomes; the same length of time is needed for examining a similar preparation of gland juice. Preparations of gland juice can be perfectly well stained first and examined later for trypanosomes; all of ours were examined in fresh cover-slip preparations because we believe it to be the easier and the quicker method; we have never examined gland juice in hanging drops.

Because the examination of fresh preparations requires only fifteen minutes, it was determined to spend only fifteen minutes in searching a smear or a thick film. This limit has been rigidly observed in all our cases save in the examination of preparations coming from cases in whom trypanosomes had been found by gland puncture. These were searched, unless trypanosomes were found sooner, for half an hour at least.

TABLE VI

	Gland Puncture		Thick Films		Thin Blood smears		Coverslip preparation	
	Single examination	Repeated examination	Single examination	Repeated examination	Single examination	Repeated examination	Single examination	Repeated examination
Trypanosomes found ...	48	2	7	1	9	0	5	1
Total ...	50		8		9		6	

This table is a record of the simultaneous examination of 283 persons, selected by gland palpation, by gland puncture, by thick blood films, by thin blood smears, and by fresh coverslip preparations of blood. The successful examinations made by each method are sub-divided so that it can be seen whether a more severe examination than that ordinarily used was employed; it must be understood that, usually, more than the allotted length of time was spent in searching for trypanosomes by each method when they had been found previously by some other method.

Because of the great length of time which it requires, attempts to centrifugalise the blood were soon abandoned, and the only methods used in each of the 283 cases, compared in Table VI, were a cover-slip preparation, a smear, a thick film of blood, and the examination of a fresh cover-slip preparation of gland juice. An inspection of this table proves that, in the Gambia, gland puncture is by far the most successful of the methods we compare. It is consequently a very valuable diagnostic method. It is doubly valuable because of its simplicity and because of the rapidity with which it can be employed. The chief value of smears and of thick films of blood is that they provide a means by which specimens, taken when there is no opportunity of examining them, may be

preserved to be searched for trypanosomes later on. Since, at least, three or four times the amount of blood required for a smear is used in making a thick film, parasites certainly ought to be found more often in thick films than in smears. Some observers have found thick films more useful than gland puncture in finding trypanosomes in some cases, especially in those cases from whom the parasites have disappeared after treatment. We have very little confidence in this method. A trypanosome may lie, unrecognisable, at the bottom of some of the heaps of débris which remain, and stain, in every thick film. Many of the trypanosomes found in thick films are only partially stained, sometimes almost nothing of the parasite can be seen beyond a nucleus and a blepharoplast. A trained microscopist who has examined many thick films may always be able to recognise such trypanosomes quickly, others can not. The time required for the preparation of a thick film is also an objection to the method. All of these reasons led to the abandonment of the dehaemoglobinised thick film method when it was first tried by us in 1903. We were searching then for a rapid routine method of recognising trypanosomiasis and we decided that the centrifugalising and fresh examination of small quantities of blood was a much better method of examining it. At that time, it was also decided, from the examination of a very considerable number of smears and cover-slip preparations, taken at the same moment, from animals and men infected with trypanosomes, that the parasites could be found more easily, living and moving, in fresh preparations than dead and motionless in stained ones. Attempts to make living trypanosomes, in cover-slip preparations of blood, more conspicuous by vital staining were also abandoned, among other reasons, because most aniline dyes evidently hastened the death of the trypanosomes; neutral red was the least harmful of those which we tried. In view of our belief that the examination of cover-slip preparations is a better method than the examination of smears, the figures given for each method in Table VI and in the paragraph describing the findings obtained by the examination of cover-slip preparations are surprising to us.

Gland palpation is very simple. Large neck glands can be recognised by any intelligent negro, and the persons possessing them can be brought to a doctor for examination by any native

policeman. Gland puncture is not a difficult manoeuvre. With the assistance of an orderly, capable of boiling a syringe, gland puncture can be done and the whole of the specimen examined in less than twenty minutes. From our experience in the Congo, in Sierra Leone, and in the Gambia, we can only conclude that gland palpation, followed by gland puncture is by far the most effectual means of finding trypanosomes in, at least, those early cases of the disease seen by us.

The shortcomings of gland palpation and puncture have always been very evident. Very early cases in whom glandular enlargement has not appeared, and late cases from whom it has disappeared may be missed by it; the missing of the latter group of cases is not serious since they are usually easily recognised by gross clinical signs. The missing of the first group is serious. At present there is no means of determining how large a proportion of the cases of trypanosomiasis present in a community will be missed by gland palpation and gland puncture; that cases will be missed is abundantly shown by work done in the Congo[2]. It was shown there that a man without enlarged glands might have trypanosomiasis in his cerebro-spinal fluid, although he seemed quite healthy and although parasites were not found in his blood; it was also shown that trypanosomes might not be found in the gland juice of a small percentage of persons although they were present in the finger blood. Many observations made since then have shown the same thing; but even if an appreciable percentage of cases is missed by this method that is no reason why the method should not be used in attempts to check the disease by the restraint and treatment of the exceedingly considerable percentage of cases which can be detected by it. It is difficult to estimate the number of cases of trypanosomiasis which will remain undetected by gland palpation and gland puncture, because there is no certain method of recognising the disease. Its absolute diagnosis rests upon the demonstration of the parasite causing it and, in our hands, the method of examination which we wish to control has been much the most efficient of all the methods at present available for finding trypanosomes; until more perfect means of diagnosis are devised, the only certain way of determining what proportion of cases of trypanosomiasis are missed by gland palpation and

puncture would be to keep a substantial number of persons who have been examined by the method under observation for a considerable period in a locality where they would not be exposed to re-infection and where it would be possible to re-examine them at intervals. The Gambia does not offer these conditions perfectly, but it does so to a considerable degree; and it is hoped that the results of future observations, made on those persons, with slightly enlarged glands, in whom we found no trypanosomes, may make it possible to form an estimate of the proportion of infected persons whom the examination of glands failed to detect there. It was attempted to keep track of the natives with enlarged glands who were examined in the Congo[3]. It is impossible to draw any certain conclusions from the reports which have been received concerning them, because many of them are mising, and because they inhabited areas where sleeping sickness is endemic. Nevertheless, an examination of the figures suggests that a larger number of those with enlarged glands, in whom trypanosomes were either not found or not looked for, ultimately died of sleeping sickness than would have been expected had they been entirely healthy persons.

We do not anticipate that the proportion of infected persons in the Gambia in whom trypanosomes have not been found by gland palpation and puncture will be a large one, if only for the following reasons. The efficiency of gland examination depends upon the selection of persons with enlarged glands for puncture. All of those with much enlarged ' + ' glands are almost always infected; in the Gambia trypanosomes were found in thirty-six out of thirty-six. Parasites are frequently found in those with moderately enlarged ' + — ' glands by a single examination (in the present instance twenty-eight out of sixty-three were infected); if such persons were detained for examination they would be examined, frequently, over a period of some weeks before being allowed to proceed[2]. It is very probable that, in this way, some of them would be shown to be infected. Always, very few cases are found among those with glands that are very slightly enlarged, ' + — — '; in the Gambia there were only four cases among 233 persons examined (see Table II). All four of these cases were persons who had moderately enlarged ' + — ' glands on one side of their neck; consequently, if they had been detained as

suspected cases, they would have been repeatedly examined before being passed as probably uninfected persons. If these four cases be subtracted, 229 persons with little more than normal glands remain; their glands were punctured and their blood was examined in cover-slip preparations, in smears and in thick films. None of them were found to be infected. Of course the result would have been more convincing had the examination been often repeated, if the blood had been centrifugalised, and if susceptible animals had been inoculated from all these persons; but the examination which they did receive was not an entirely insignificant one, and we believe that the immediate future will not show that many individuals among these 229 persons had trypanosomiasis when they were examined.

The glands of two persons, one a ' + ' case, the other a ' + — ' case, in whom trypanosomes were found by examining the blood, were not punctured; it is probable that gland puncture would also have detected the parasites. In one instance trypanosomes were found in a blood smear from a ' + — ' case in whom parasites were not found by a single perfect examination of gland juice. We regret that most of our blood smears and thick films were not examined until our return to England, and that it was consequently impossible to examine these persons by gland puncture until we were satisfied that trypanosomes could be found in them by this method of examination.

It must be remembered that trypanosomes can be found in the lymphatic glands of any group, and that the femoral or axillary glands can often be punctured when those of the posterior cervical triangles are too small to be examined. The continued observation of a series of suspected or actual cases of trypanosomiasis, in whom trypanosomes can not be found by gland puncture, is greatly needed; it might throw interesting light upon the course and development of the disease.

The use of gland palpation and puncture was first urged as the basis of measures intended to check the spread of trypanosomiasis because of figures obtained, in the Congo Free State, from the simultaneous examination by different methods of several hundred persons; 250 of them were cases of trypanosomiasis. The work which led to these results was the direct outcome of an observation

made by Greig and Gray, that trypanosomes were present in the glands of persons with trypanosomiasis. We had long been searching for a rapid method of diagnosing the disease, and the idea at once presented itself that such a method might be found in gland puncture[17]. In the hope of finding a part of the body in which the trypanosomes occurred in larger numbers than in the blood, a series of preparations had been taken immediately after death from the organs and body-fluids of many persons and animals; in only one case, examined within half an hour after death, were living trypanosomes, found in the glands[25]. This observation is an interesting one, since it emphasises, and may have some relation to the fact that trypanosomes sometimes die very quickly in preparations of gland juice. Consequently, preparations obtained by the puncture of glands must be examined as soon as they are made.

Methods exactly similar to those used in the Congo have been employed by us, or by one of us, in the Gambia and in Sierra Leone with the same results. Similar results have been obtained by many persons in many parts of Africa; yet, it is true that gland palpation and puncture have failed to detect cases of trypanosomiasis in Ashanti, on the Gold Coast, in Nyasaland[18], and elsewhere. As far as the Nyasaland cases are concerned it will be interesting to observe whether human trypanosomiasis there, which is said not to be caused by that parasite, runs the same course as the disease produced by *Trypanosoma gambiense*.

VII. THE PRACTICAL APPLICATION OF GLAND PALPATION AND PUNCTURE

Although we have urged, and do still urge, that gland palpation and puncture should be made the basis of measures enforced, in areas, where human trypanosomiasis exists or threatens to become endemic, with the object of collecting natives for treatment and isolation in some type of restricted settlement; we do not, in any way, urge that this method should be used in the maintenance and administration of such measures to the exclusion of all other methods of diagnosing trypanosomiasis. It is a very efficient method of diagnosis; in our experience it is the most efficient one.

It is almost the quickest of the methods in individual examinations, and by it a large percentage of infected persons can be weeded out from a whole population infinitely more quickly and more cheaply than can be done in any other way. It is possible that other methods might detect a slightly larger percentage of infected persons, but economic exigencies—expense—will frequently make it impossible to employ enough trained physicians to carefully examine every native in a district by the tedious, though possibly more efficient, methods of centrifugalisation of the blood; the expense of maintaining a staff of physicians and native assistants capable of examining the native population in that district by gland palpation and puncture would be very much less.

No one can deny that gland palpation and puncture form a very efficient method of diagnosing trypanosomiasis; in our hands it has been the most efficient of all methods, although it does sometimes fail. It would be regrettable if the extravagant claims which have been made for the method should lead to a reaction by which its real value might be obscured.

In our experience it has not be a difficult method to employ. Natives whose glands are punctured feel nothing after the prick of the needle and, which is almost as important, they can see nothing. Once or twice whole villages have become frightened and refused to be examined; but that has been very unusual. Tact and a generous distribution of sweets, beads, kola nuts and small novelties has usually successfully overcome all distrust[14].

In practice, we believe that much can be done in many parts of Africa to control trypanosomiasis if measures suggested by a knowledge of the incidence of the disease are enforced. That knowledge, in our opinion can be gained most quickly and easily by gland palpation and puncture. Just as the French Commission, the German Commission, Broden and Rodhain and others have observed, it was seen in the Congo that some cases—especially very early ones and late ones—are missed by the examination of single preparations of gland juice, or of even several preparations taken during a period of a few days. Consequently, when it is possible, gland palpation and puncture must be supported by other, though less efficient, methods.

The presence of auto-agglutination, of increased pulse-rate and

of heightened temperature in persons, apparently otherwise healthy, will always be suspicious and, as is suggested by the paragraphs dealing with these signs, be sufficient to cause the examination of persons possessing them to be persevered in. But, none of these signs have any diagnostic value in themselves. The value of examining the blood for trypanosomes by inspection and by animal inoculation is admittedly very great, and these devices must be employed where it is necessary to do so.

In our opinion the most convenient and most effectual order for the routine examination of persons for trypanosomiasis is gland palpation and puncture, cover-slip preparation of blood, centrifugalisation of the blood, thick blood films, blood smears and animal inoculations. Auto-agglutination and clinical signs are valuable, but they are merely suggestive.

VIII. NATIVE TOLERANCE OF TRYPANOSOMIASIS

An inspection of Tables III and IV shows that we saw no cases of enlarged glands, nor of trypanosomiasis, in persons past middle age. In reviewing these tables, it was suggested that this absence of cases might be explained in part by the lack of exposure to infection of those past middle age, because of the occupations which they follow; but, it may be that this lack of cases is due to an immunity acquired later in life. The idea is not a new one[1, 14, 21].

The fact that trypanosomiasis has been present in the Gambia and elsewhere on the West Coast of Africa for many years, in places where *Glossina palpalis* exists, without assuming the epidemic form which it has taken in the Congo Free State and in Uganda, of itself, suggests that the West Coast natives may have acquired some immunity to it. In the Gambia the customs of natives, almost none of whom were riverine, has doubtless much to do with preventing the spread of trypanosomiasis; but there seems to be something more than that.

There are many records, some based altogether on the observations of Europeans, others based on observations of natives and of Europeans, of persons who have lived for four or more years after they probably became infected by trypanosomes; these records prove that persons may have a 'tolerance' for trypanosomes

and live comparatively healthily though infected by them. This fact must be remembered in appreciating the results of treatment, for it must be asked whether an improvement in the condition of a patient has been due to the drug administered or whether the treatment has merely coincided with the commencement of a period of tolerance in which the parasites are not necessarily destroyed, although the effect produced on the patient by them almost disappears.

Little is known of the reasons which may cause trypanosomiasis to assume an acute phase. In experimental animals it is known that an intercurrent infection may determine a sudden multiplication of trypanosomes. It may be that some similar factor which 'produces a lessened resistance' might be the cause of an acute phase of trypanosomiasis in persons who had previously had a chronic form of the disease.

Almost nothing is known of the outcome of those cases of trypanosomiasis in whom parasites are present, although there are almost no symptoms. It is not known whether they recover, nor, if they die, for how long the disease may run a chronic course.

It may be suggested that the overwhelming preponderance of middle-aged persons in our infected cases might be explained by the chronic nature of the infection which allowed those infected in youth to live on to middle-age, still infected, but tolerant of their infection. In that case the absence of cases after middle-age might be the expression of an immunity acquired as the result of a preceding persistent infection.

Observations on these points are needed badly; it is to be hoped that many of those who were found to be infected in the Gambia by this expedition can be followed. It is worth noting that all of the six persons who were found to be infected in the Gambia in 1902 were dead in 1906.

IX. RECOMMENDATIONS

It is not our intention to propose a scheme for the prevention of sleeping sickness in the Gambia. To do so is the province of the Resident Medical Officers, and it is they who will decide which of the measures, which have been employed elsewhere in the prevention

of sleeping sickness, are most applicable to the situation in the Colony of the Gambia.

There are, however, a few very evident improvements to be made which may be mentioned. The situation of the town of Essau, where five per cent. of the population are infected with trypanosomes should certainly be changed. The town is at present placed at the side of a swamp and is almost enclosed on two sides by mangroves. As a result *Glossina palpalis* is often seen within the village. Demban Kai, where 4·3 per cent. of the population are infected is situated almost as badly. It should be moved. Mandinaba where three out of twenty-two persons were probably infected, might, also, be moved.

There are many fords and river-side washing places which are closely enclosed by mangrove bush and by other thick vegetation. Tsetse-flies are always present in such places; consequently the natives who frequent them are constantly bitten, and it would be well if all the thick brush about fords, wharfs, or places used for washing by women, could be cleared for a distance of at least 150 yards on every side. The strip of bush just to the south of the town of Bakau, at Cape St. Mary, swarms with *Glossina palpalis*. The thick undergrowth should be cleared from this bush, and that especially if it is determined to establish permanent European quarters at the Cape. At present this bit of jungle is a menace to the neighbouring native town and to everyone who passes through it.

The growing of rice should be forbidden in places where the fields are in swamps near the river, where *Glossina palpalis* exists; most of the rice-fields in the Gambia are of that sort. It is possible that 'mountain rice' (*Oryza sativa*, var.), which will grow in comparatively dry places, might be substituted in the Gambia for the present variety, which can only be grown in marshes. Even if 'upland' or 'mountain rice' cannot be grown, the prohibition of the cultivation of marsh rice would not be a great hardship. Many natives, for example, those to the north of the Niumi Forest, eat no rice and they, like many others, look on it as a luxury rather than a necessity. Many of those who grow rice have eaten it all within three or four months of the harvest time, and for the rest of the year live on other grains. Others eat it regularly twice, or even

three times a week. Very few of the towns use maize as much as they might do and, possibly, it might be substituted for rice extensively.

We believe that much can be done to improve the situation in the Gambia by such methods and by the isolation and treatment of infected persons who would be detected, largely by systematic gland palpation of the whole population. There is very much in the description of the preventive measures employed in the Congo Free State which seems to be good (Sleeping Sickness Bulletin, No. 26, p. 193). The clauses which forbid the concealment of cases, make notification of cases compulsory, and make traders and other employers of labour responsible if infected persons with enlarged glands are found among their employés, seem to be especially praiseworthy.

The examination of the population and the treatment and maintenance of the cases detected would be placed under the direction of, probably, two medical officers appointed for that purpose and assisted by native orderlies and inspectors. From our talks with the natives, we do not think that it would be very difficult to persuade them to send cases of trypanosomiasis, at least those in whom symptoms are evident, to villages established for observing and treating them. It would be comparatively easy to get the natives to come to them if two such villages were established in the Gambia, one near the sea coast, and a second up the river, probably at McCarthy Island. The establishment of such villages would be worth while, if only for the sake of the observations which it would be possible to make from them on the course of the disease in persons sent to them. It would be worth while also, from the patients' point of view, for it does seem certain that, in some instances, early, radical and persevering treatment may cure trypanosomiasis.

The physicians attached to the sleeping sickness isolation villages would have opportunities for studying many interesting points which can only be investigated by those resident in the Colony for considerable periods. Not the least of these would be the careful examination of a large number of native and wild animals in order to ascertain whether *Trypanosoma gambiense* occurred naturally in any of them.

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X. CONCLUSIONS

1. Gland palpation and puncture is, by far, the most effectual of the procedures, employed by us in the Gambia, for the diagnosis of human trypanosomiasis.

2. At least 0·8% of the population of the Gambia are infected with trypanosomes.

3. Measures designed to control human trypanosomiasis may be usefully instituted in the Gambia; they should include a continued examination of the whole population, the establishment of villages for the isolation, observation, and treatment of cases, and the appointment of a special staff for the administration and execution of these projects.

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The route followed by the Expedition is indicated thus, ——.
The names of towns where natives were examined are underlined.
NIUM-BATO
Dense Forest
Bamboo Forest
Bamboo and Small Trees
Grass Land
Cultivation
Swamp
Hill Forest
Small Trees
Bare Ground
Rocky Ground
Sandy Ground
Stony Ground
Gravelly Ground
Ant Hills
Native Villages
Native Farms
Native Paths
Rivers
Streams
Water
Boundaries
Roads
Telegraph Line
Mountains
Hills
Escarpments
Contours
Heights in Feet
Heights in Metres
Scale of Miles
Scale of Kilometres
Compass Bearings
Latitude
Longitude
Meridian
Parallel
Camp
Station
Fort
Church
Mission
Bridge
Ford
Well
Spring
Cave
Waterfall
Rapids
Lake
Pond
Marsh
Island
Peninsula
Bay
Harbour
Anchorage
Lighthouse
Buoy
Reef
Shoal
Sandbank
Coral
Mangrove
Palm Trees
Baobab Trees
Cotton Trees
Rubber Trees
Gum Trees
Fruit Trees
Cultivated Land
Uncultivated Land
Pasture Land
Meadow
Orchard
Vineyard
Plantation
Garden
Park
Cemetery
Ruins
Old Fort
Old Camp
Old Station
Old Church
Old Mission
Old Bridge
Old Ford
Old Well
Old Spring
Old Cave
Old Waterfall
Old Rapids
Old Lake
Old Pond
Old Marsh
Old Island
Old Peninsula
Old Bay
Old Harbour
Old Anchorage
Old Lighthouse
Old Buoy
Old Reef
Old Shoal
Old Sandbank
Old Coral
Old Mangrove
Old Palm Trees
Old Baobab Trees
Old Cotton Trees
Old Rubber Trees
Old Gum Trees
Old Fruit Trees
Old Cultivated Land
Old Uncultivated Land
Old Pasture Land
Old Meadow
Old Orchard
Old Vineyard
Old Plantation
Old Garden
Old Park
Old Cemetery
Old Ruins
Old Fort
Old Camp
Old Station
Old Church
Old Mission
Old Bridge
Old Ford
Old Well
Old Spring
Old Cave
Old Waterfall
Old Rapids
Old Lake
Old Pond
Old Marsh
Old Island
Old Peninsula
Old Bay
Old Harbour
Old Anchorage
Old Lighthouse
Old Buoy
Old Reef
Old Shoal
Old Sandbank
Old Coral
Old Mangrove
Old Palm Trees
Old Baobab Trees
Old Cotton Trees
Old Rubber Trees
Old Gum Trees
Old Fruit Trees
Old Cultivated Land
Old Uncultivated Land
Old Pasture Land
Old Meadow
Old Orchard
Old Vineyard
Old Plantation
Old Garden
Old Park
Old Cemetery
Old Ruins

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